

## AMENDED CLAIMS

JAP8 REG'D PCT/PTO 09 DEC 2005

[received by the International Bureau on 09 February 2005 (09.02.05);  
original claims 1 to 33 replaced by new claims 1 to 20 (4 pages)]

1. A method for reconstructing a surface from at least one arbitrary three-dimensional entity obtained from a target surface, comprising:  
obtaining a set of at least one three-dimensional entity and a position for said at least one entity in a common three-dimensional coordinate system, each entity being a set of three-dimensional points, each said point containing at least the three-dimensional coordinates of said point on said target surface, wherein said entity is one of an unorganized cloud, a three-dimensional curve and a range image;  
constructing a volumetric implicit representation of said target surface in the form of a vector field using said set, each vector in said vector field containing at least the distance to said target surface and the direction toward said target surface;  
reconstructing said target surface from the information contained in said vector field.
2. The method as claimed in claim 1, wherein said set of at least one entity includes at least one entity being one of said unorganized cloud and said curve.
3. A method for refining an alignment of arbitrary three-dimensional entities obtained from a target surface, comprising:
  - (a) obtaining a set of at least two three-dimensional entities and a position for said at least two entities in a common three dimensional coordinate system, each entity being a set of three-dimensional points, each said point containing at least the three-dimensional coordinates of said point on said target surface, wherein each said entity is one of an unorganized cloud, a three-dimensional curve and a range image;
  - (b) constructing a volumetric implicit representation of said target surface in the form of a vector field using a subset of at least one entity of said set, each vector in said vector field containing at least the distance to said target surface and the direction toward said target surface;
  - (c) selecting at least one obtained entity;

- (d) obtaining a subset of said points on each of said selected entities, points in these subsets being called control points;
  - (e) for each control point in each selected entity, computing a contribution to a cost function, said contribution being a function of at least said vector field and said coordinate of said control point;
  - (f) for each selected entity, computing a new position that optimizes its corresponding cost function; and
  - (g) placing each selected entity in said vector field at its newly computed position and updating said vector field accordingly.
4. The method as claimed in claim 3, wherein said set of at least two entities includes at least one entity being one of said unorganized cloud and said curve.
5. The method as claimed in any one of claims 3 to 4 wherein steps (c), (d), (e), (f) and (g) are repeated until a set of convergence criteria is met.
6. The method as claimed in any one of claims 3 to 5, wherein
- said step (b) comprises placing at least one entity in said vector field and updating said vector field accordingly; and wherein
- said step (c) comprises selecting at least one of said entities not yet placed in said vector field and placing said selected entities in said vector field without updating said field.
7. The method as claimed in any one of claims 1 and 2, wherein a subset of said points contains surface properties measured on said target surface.
8. The method as claimed in any one of claims 3 to 6, wherein a subset of said points contains surface properties measured on said target surface.
9. The method as claimed in claim 8, wherein said cost function is a function of said surface properties measured on said target surface.
10. The method as claimed in any one of claims 7 to 8, wherein at least one of said surface properties measured on said target surface is a grayscale value associated to said point.

11. The method as claimed in any one of claims 7 to 8, wherein at least one of said surface properties measured on said target surface is a color information associated to said point.
12. The method as claimed in any one of claims 7 to 8, wherein at least one of said surface properties measured on said target surface is an information describing the surface texture associated to said point.
13. The method as claimed in any one of claims 1 to 12, further comprising :  
using a ranging sensor to produce said set of entities.
14. The method as claimed in claim 13, wherein said ranging sensor is held in hand by an operator.
15. The method as claimed in claim 13, wherein said ranging sensor is moved by a mechanical device.
16. The method as claimed in any one of claims 1 to 15, wherein said three-dimensional points are all measured in a single plane and the three-dimensional coordinate system can be reduced to a two-dimensional coordinate system.
17. A system for reconstructing a surface from at least one arbitrary three-dimensional entity obtained from a target surface comprising:  
a three-dimensional entity provider for obtaining a set of at least one three-dimensional entity and a position for said at least one entity in a common three-dimensional coordinate system, each entity being a set of three-dimensional points, each point containing at least the three-dimensional coordinates of said point on said target surface, wherein said entity is one of an unorganized cloud, a three-dimensional curve and a range image;  
an implicit representation constructor for constructing a volumetric implicit representation of said target surface in the form of a vector field using said set, each vector in said vector field containing at least the distance to said target surface and the direction toward said target surface; and  
a target surface reconstructor for reconstructing said target surface from the information contained in said vector field.

18. The system as claimed in claim 17, wherein said set of at least one entity includes at least one entity being one of said unorganized cloud and said curve.
19. A system for refining an alignment of arbitrary three-dimensional entities obtained from a target surface, comprising:
- a three-dimensional entity provider for obtaining a set of at least two three-dimensional entities and a position for said at least two entities in a common three-dimensional coordinate system, each entity being a set of three-dimensional points, each point containing at least the three-dimensional coordinates of said point on said target surface, wherein each said entity is one of an unorganized cloud, a three-dimensional curve and a range image;
  - an implicit representation constructor for constructing a volumetric implicit representation of said target surface in the form of a vector field using said set, each vector in said vector field containing at least the distance to said target surface and the direction toward said target surface; and
  - a control point selector for selecting at least one entity used in said vector field;
  - a subset provider for obtaining a subset of points on each of said selected entities, points in these subsets being called control points;
  - a cost function calculator for computing, for each control point in each selected entity, a contribution to a cost function, the contribution being a function of at least the vector field and the coordinate of the control point;
  - a new position calculator for computing, for each selected entity, a new position that optimizes its corresponding cost function.
- wherein the implicit representation constructor places each selected entity in the vector field at its newly computed position and updates the vector field accordingly.
20. The system as claimed in claim 19, wherein said set of at least two entities includes at least one entity being one of said unorganized cloud and said curve.